Have Adversary Missiles Become a Revolution in Military Affairs?

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The United States last had relative parity with the missile forces of potential adversaries in the early 1990s.[1] Since then, the gap between our air and missile defense (AMD) capabilities and those of threat missile forces has continued to widen. Initially, this occurred because of the ability of our adversaries' rapidly increasing numbers of ballistic and cruise missiles and long-range rockets to overwhelm US forward-based AMD systems. For the most part, threat bal-

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listic missiles were unsophisticated variants of modified and improved SCUD missiles.[2] The late 1990s saw China, Russia, Iran, North Korea, and others fielding more sophisticated ballistic missiles that utilized solid fuel, inertial and Global Positioning System guidance, greater warhead lethality, extended ranges, improved mobility, and onboard and standoff countermeasures. These weapons were supported by increasingly advanced command and control (C2), doctrine, training, and targeting capabilities. At the same time, our opponents have seen the great success the United States has enjoyed with precision attack Tomahawk cruise missiles.

Adversary missile-attack doctrines, as demonstrated in numerous experiments and war games, have involved a low number of launches from static positions to large, complex salvoes from mobile forces.[3] Threat targeting has evolved from area targets (e.g., cities) to point targets (e.g., airfields and ports). The threat attacks in these war games and experiments have been supported by advances in terrestrial and aerial intelligence, surveillance, and reconnaissance (ISR); electronic warfare; unmanned aircraft systems (UAS); and probably space-based ISR. It appears that even the legacy missiles are being (relatively) improved inexpensively by having them retrofitted with advanced capabilities. The SCUDs of today are not the SCUDs of 1991; the SCUDs of the future will not be the SCUDs of today. Similarly, large and unsophisticated antiship cruise missiles (e.g., Styx) have evolved into advanced supersonic (soon hypersonic) antiship and land attack cruise missiles.

Improvements to the adversary's missile force capabilities as well as capacity (i.e., both technical improvements and growing numbers) continue and are widening the gap between those missiles and US AMD (see the figure below). This article maintains that the capabilities developed and employed by threat missile forces have evolved over the last decade from just another battlefield threat into a game-changing revolution in military affairs (RMA). Consequently, the US military must fundamentally change its approach to countering them.[4]

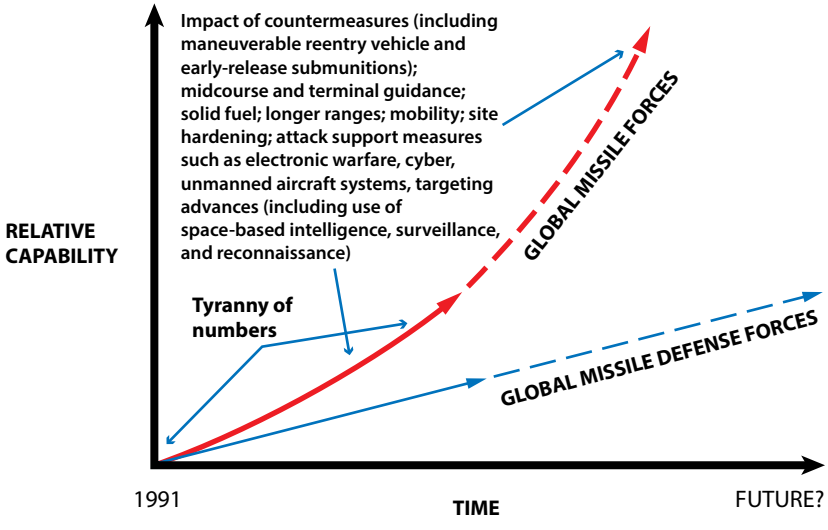

Figure. Trends in missiles and missile defense. The global gap between our missile defense and our adversaries' missile capabilities is growing and appears to be accelerating. This figure makes no attempt to quantify these trend lines but simply illustrates the problem in conceptual terms. (Adapted from Institute of Land Warfare, Association of the United States Army, *U.S. Army Integrated Air and Missile Defense Capabilities: Enabling Joint Force 2020 and Beyond*, Torchbearer National Security Report [Arlington, VA: Institute of Land Warfare, Association of the United States Army, May 2014], 13.)

What Is a Revolution in Military Affairs?

RMA is a widespread term but lacks a commonly agreed upon definition.[5] This article uses two of the most useful ones. First, Andrew F. Krepinevich asks,

> What is a military revolution? It is what occurs when the application of new technologies into a significant number of military systems combines with innovative operational concepts and organizational adaptation in a way that fundamentally alters the character and conduct of conflict. It does so by producing a dramatic increase—often an order of magnitude or greater—in the combat potential and military effectiveness of armed forces.[6]

The second definition, from a RAND study of 1999, is useful because it addresses the impact on current core competencies:

> An RMA involves a paradigm shift in the nature and conduct of military operations
> - which either *renders obsolete or irrelevant* one or more *core competencies* of a dominant player,
> - or creates one or more new core competencies, in some new dimension of warfare,
> - or both.[7] (emphasis in original)

To qualify as an RMA, threat missile forces would have to apply technologies synergistically in innovative ways that give them a significant increase in their strategic, operational, and tactical war-fighting capabilities so that they effectively render our current ability to counter them cost-ineffective and thereby affect our conduct of global power projection.

Just as no official definition of RMA exists, so is there no common agreement on RMAs throughout history. We do, however, see some common threads. For example, technologies that made up RMAs existed in many cases for a long time; RMAs defined warfare for a significant period following their introduction; and they were subsequently supplanted by other (counter) RMAs. Consider armored knights and castles. With the decline and fall of the Roman Empire, they were the RMAs of their era. Horse-mounted soldiers had existed for thousands of years prior to the feudal era, as had fortified locations, yet they defined military operations during their "time in the sun." They also helped define the economic, diplomatic, and social fabric of the era.

This state of affairs continued until the introduction of massed longbow archers during the Hundred Years' War between England and France. The battlefields of Crécy, Poitiers, and Agincourt quickly rendered the armored knight irrelevant. Non-nobles could slaughter members of the established order at distance with relative impunity and little expense before the knights could close with the bowmen. Heavier armor was not cost-effective against stronger bows or crossbows with

bodkin points in large numbers. Cavalry would still have a role on the battlefield but would not dominate as it had for so many centuries.

Similarly, castles made defense dominant until projectiles powered by gunpowder made them rapidly obsolete. It was not cost-effective to greatly increase the thickness of curtain walls because the creation of more powerful artillery proved relatively simple and inexpensive.[8] The introduction of massed, armor-penetrating longbows/crossbows and of gunpowder artillery fundamentally changed the nature of warfare and had huge political, social, and cultural implications for the feudal era. Just as powered projectiles rendered castles and armored horsemen obsolete in short order (with corresponding strategic and operational effects across the doctrine, organization, training, materiel, leadership and education, personnel, and facilities [DOTMLPF] spectrum), so does it seem plausible that large numbers of accurate, responsive, and lethal missiles with ever-longer ranges are having the same effect on "the established order" (i.e., US global power projection) in the early twenty-first century.

Why Did Bows and Gunpowder Become an RMA?

Bows existed for millenniums prior to the Hundred Years' War. Similarly, gunpowder was present for centuries before it upset the social order.[9] What was different? Why did they suddenly become "game changers"?

The game-changing factors were a synergistic mix of mass employment, innovative tactics, cost-effectiveness (they were much cheaper than castles and armor/horses), penetration power, accuracy, and range integrated with a few new technologies (e.g., iron and bronze castings for cannon) that doomed castles and armored horsemen.[10] Guns were a natural follow-on to gunpowder artillery and eventually became the RMA that eliminated the mass formation of longbows.[11] These game-changing factors are the same ones that are enabling the adversary's missile capabilities to upset the current established order

of US power projection based on aircraft carriers, intermediate staging bases, forward air bases, ports, and so forth, as well as their supporting missile defenses in the early twenty-first century. Like bows, guided missiles have been around for a long time (since World War II), but they now appear to have evolved into a game changer.[12]

Why Have Adversaries Chosen Missiles?

Consider our current enemies' strategic issue: they want freedom of action within their regions to execute their political and military strategic plans. However, they must confront the long-standing US strategy of balance of power enabled by a policy of selective global interference. Since the early days of the Cold War, the United States has built and relied upon global power projection to execute this strategy.[13] It has been the primary player on the world stage for decades, based upon its geographic isolation and power projection established during and after World War II. We must also note that when America has executed power-projection operations, regime change has frequently been the result. So the calculus for our potential adversaries is fairly simple: how do they gain regional freedom of action without risking regional US interference, especially when that could result in regime change?

Of course, the United States has long assumed that its power-projection strategy and enabling capabilities would deter many adversary actions that ran contrary to US interests. This assumption was and is naïve. In actuality, our potential adversaries were forced to develop cost-effective means to provide their desired freedom of action (antiaccess) or, if that failed, to ensure that America could not prevent the attainment of their regional objectives (area denial), all the while preserving their regimes.[14] It was not cost-effective for most of those adversaries to develop an air force that could compete with US Air Force / Navy manned aircraft, but they still had to project power regionally and protect themselves from US intervention. Their answer was to develop and field an ever-increasing number of missiles that could also be used

for delivery of weapons of mass destruction (WMD).[15] In a very general sense, a missile RMA is the ultimate expression of asymmetric warfare because it threatens adversaries at all levels in ways neither easily nor inexpensively countered.[16]

What Characteristics of Adversary Missile Capabilities Enable Them as an RMA?

Our potential enemies have taken a horizontally integrated and holistic (or cross-domain) approach to developing their missile capabilities into an RMA.[17]

Survivability

Extensive denial and deception planning seems a fundamental part of all doctrines of threat missile forces. Underground facilities supporting a "shell game" with high-fidelity dummies and decoys are a part of their solution.[18] Our adversaries have seen the publicly reported difficulty the United States has encountered in finding and killing mobile targets in its recent wars; thus, missile mobility is of key importance. Kosovo, the first Gulf War, and Operation Odyssey Dawn are well-known examples of our trouble with finding targets on the ground.[19] Furthermore, we will likely see a growing proliferation of high-end integrated air defense systems primarily to protect WMDs, C2, and missile-delivery systems. The United States must assume that its foes have a pretty good idea of US signals/imagery/electronic intelligence capabilities that enable time-sensitive targeting and will seek either to deceive or deny us that intelligence. Adversaries are also investing in launcher mobility as another survival capability.[20] Attacking a missile launch point 20 minutes after the launcher has departed is wasted effort.[21]

Responsiveness

Our adversaries are shifting to solid-fuel missile technology because of the responsiveness factor. Missiles that don't have to be fueled prior to

launch can support rapid strikes on targets of opportunity. This capability also makes training much easier and improves survivability insofar as the missile units have smaller footprints, impeding detection by US ISR. Moreover, adversaries are fighting on their own ground and can establish numerous presurveyed launch points located near dispersed hiding sites and prestocked reloading sites.[22]

Accurate Targeting

Without near-real-time precision ISR, no precision attacks can occur. This is true for both the United States and its potential opponents. America has taught the entire world this lesson over the last 10 years. In fact, our enemies have observed that we are so convinced of our ability to conduct precision targeting and attack that we are doing away with area effect weapons in order to meet international treaty obligations. Much of the US ability to carry out precision targeting comes from either space or UAS ISR. Potential adversaries are developing similar capabilities to support the targeting of missiles (e.g., UASs) while scheming to degrade/disrupt/deny America's space-based and aerial ISR of their missile forces. Several of our foes are exploring counterspace options as a means of further disrupting US space-based ISR.[23]

Effectiveness

Adversary missiles are being deployed in numbers and with technical sophistication to defeat likely AMD operations. If these missiles are not perceived as capable of producing the desired effects due to US and allied missile defenses, then all of their efforts are for naught. Hence, we see various adversary capabilities under development to degrade AMD sensors (e.g., advanced low-power jamming); destroy those sensors (e.g., special operations forces, Harpy UASs, electromagnetic pulse, and antiradiation warheads); degrade AMD C2 (e.g., cyber spoofing, data link, and Global Positioning System jammers); saturate AMD (e.g., large missile volley sizes, early-release submunitions, and on-

board countermeasures); and defeat our ballistic missile defense interceptors (e.g., maneuverable reentry vehicles).[24]

Cost Benefits

Missiles are cheaper than the offensive air force they replace.[25] Furthermore, they appear significantly less expensive than the missile defense that must be developed to counter them. This fact is critical if they are to be fielded in sufficient numbers to produce the desired strategic and operational regional effect.[26] One estimate for the cost of old-model SCUD missiles is from less than $1 million to $3 million.[27] Other sources report the cost of the Chinese CSS-6 and CSS-7 at $500,000 and of Chinese air launched cruise missiles at $175,000.[28] US Patriot missiles that currently are intended to counter them are individually much more expensive, and it is likely that more than one Patriot would be fired at each incoming threat missile. Although newer solid-fuel missiles (e.g., Iran's Fateh 110 or Russia's SS-26) are probably more costly, the improved Patriot and naval standard missiles (Aegis) are also significantly more expensive. Further, the more modern threat missiles have much greater effectiveness. Consider the number of missiles a country can purchase against the cost of one modern aircraft. The same is true for aircraft carriers and antiship missiles.[29] If the new USS *Gerald Ford* costs $13 billion and a DF-21D antiship ballistic missile costs $11 million, then the Chinese could build over 1,200 missiles for the cost of every carrier that the United States constructs going into the future.[30] The trend toward warhead upgrades with early-release, terminally guided submunitions and accurate, cheap, long-range rockets and supersonic/hypersonic cruise missiles exacerbates the AMD problem by at least an order of magnitude.

Credibility

Our possible opponents expend significant resources each year on improving the reliability of their missiles, training their crews, and demonstrating their ability to orchestrate increasingly large, complex mis-

sile attacks.[31] We struggle to shoot several missiles per year in testing whereas they fire large salvoes despite the impact on their national treasury and defense budgets. The repeated testing of missiles also has a positive effect on other countries in the region (from the adversary's perspective, of course).[32]

Command and Control

Infrastructures for missile forces are being developed to make them controllable under all circumstances. Because threat missiles are frequently coupled closely to their WMD programs, they fall under the same C2 concepts—much like our widely reported nuclear C2.[33] This means survivable, redundant, isolated C2 with the ability to function in degraded environments. All of our adversaries have studied how the United States took down the Iraqi integrated air defense system and national C2; furthermore, many of them have already been subjected to disruptive cyber attacks in other areas. We must assume they will move to mitigate these cyber threats and adjust their C2 architectures accordingly.

All of the above characteristics have three purposes: (1) to deter the United States from entering the opponent's region during a crisis if it is not already there or to deter America from actions if it is present in the region (i.e., the hostage effect); (2) to prevent US forces (either initial-entry or reinforcing troops) from gaining access to the adversary's region in times of conflict; and (3) if (1) and/or (2) fail, to make it too expensive for America to stay in the fight and prevent regime change. In short, adversaries may in fact not be able to defeat Army brigade combat teams in a fight, but if they prevent them from getting into the region or from having freedom of maneuver there, that fact becomes irrelevant.

If Adversary Missile Forces Are an RMA, What Are the Implications?

Historical examples of attempts to counter RMAs typically suggest several insights. Incremental improvements in the weapon systems that the RMA attacks rarely succeed, and it is frequently prohibitive in terms of cost and operations to improve those systems significantly. For example, throwing more massed knights at a longbow-supported position would have little effect. Putting thicker armor on the French knights was very expensive and relatively easy to counter (to say nothing of the effect of additional weight on the mobility and stamina of the horses). The costly proposition of thickening the stone curtain walls of castles would not have much effect on artillery, which could easily adjust. A key question becomes, can the United States afford to field sufficient missile defense forces and equip them with adequate missiles to counter the threat's missile forces in the future? If the answer is no and if we intend to preserve our global power projection, then we must look beyond our current capabilities. Adversary RMAs generally require a cost-effective RMA to counter them. More of the same is unlikely to succeed. Historically, it appears that a game changer can be effectively countered only with a game changer, and it takes time to develop and converge the technologies necessary to do so.

RMAs seem to be developed and employed by countries as a reaction to their perceived weaknesses (e.g., their inability to counter US power projection). Global powers have less incentive to develop RMAs because of their investments in the things that allowed them to become global powers. In fact, we frequently find considerable bureaucratic resistance to doing so.[34] The United States had no need to cultivate missiles as an RMA since it had developed and deployed forward-based air forces and carrier battle groups for power projection. In fact, missiles were the adversarial reaction to those US power-projection capabilities. Moreover, the Intermediate-Range Nuclear Forces Treaty limits the options that America can deploy.[35]

The country that develops and fields an RMA has no incentive to stop those processes until the RMA loses its effectiveness. We should expect to see more and more modernized missiles until our AMD proves that these weapons can no longer assure our adversary's regional dominance and regime survival.

RMAs by themselves do not guarantee ultimate victory in a conflict. Longbows were devastating to the French nobility, but France still won the Hundred Years' War.[36] RMAs appear to have their greatest impact before the other side can adjust, especially if they are used in conjunction with strategic or operational surprise. At Crécy, Poitiers, and Agincourt, the longbow archers proved dominant; later at Patay, they were slaughtered. German panzer divisions were arguably an RMA in 1939 when they overran Poland and subsequently France in 1940.[37] Yet, they were stopped cold by the Soviets at Kursk in 1943. The US RMA of global power projection based upon forward air bases and carriers has yet to engage an adversary with a large, modern, well-trained missile force. Saddam Hussein's missile forces of 1991 have more in common with the German V-1/V-2 force of 1944 than the Chinese, Russian, North Korean, or Iranian missile forces of 2014.

RMAs appear to function best when they are part of a holistic and integrated "system of systems." Longbows were supported by dismounted knights and men at arms and defended by field fortifications (e.g., sharpened stakes). Artillery battering of a castle could be subjected to surprise sorties, and the structure was defended by field fortifications with infantry and backed by cavalry reserves. German panzer divisions employed innovative tactics supported by radios and close integration with motorized infantry, artillery, antitank forces, close air support, and so forth. Missiles best become a game changer when supported by full-spectrum ISR for rapid targeting, high-fidelity decoys and dummies, isolated and redundant communication networks, modern air defenses, stealthy UASs, advanced electronic warfare and cyber capabilities, and robust, redundant underground facilities.

RMAs frequently produced significant disruptive effects that went beyond those of the military, including those of a second- and third-order social, political, and economic nature. Consider the impact of the longbow and the demise of castles on feudal Europe. The RMA caused some of these disruptive effects; others resulted from capabilities developed to counter the RMA. We know intuitively that any curtailment of the United States' ability to conduct global power projection could have significant, long-term social, political, and economic repercussions worldwide. At the very least, it would give rise to regional powers.

Analysis

All of that said, have threat missile forces evolved into an RMA? It certainly appears so even though we typically do not know or understand an RMA as such until after battlefield disaster(s). Certainly the last four years of US military service war games have shown strong indications that missiles not only have evolved into a game changer but also will present formidable challenges at the strategic, operational, and tactical levels.[38] The very existence of a game-changing RMA missile threat has altered many a US war-game-planning mission analysis and/or "decision calculus" in reference to such factors as whether to operate the US desired forces (who), in a contested area (where), and at a time during which their operations are most necessary (when). In short, war-game results indicate an increased trend toward threat missile "risk avoidance" with that weapon's ranges defining the boundary of some of our operations. It seems certain that many of our potential adversaries believe their missiles are game changers based on the number of resources dedicated to further development.

If missiles have transitioned into an RMA in the last 10 years or so, then it would follow that we ignore that shift at considerable peril. Whereas it is true that the military services are starting to come to grips conceptually with the adverse potential of threat missile forces, military acquisition programs appear to have yet to catch up with this thinking. Much of this is probably due to the same historical bureau-

cratic resistance that has always hindered predisaster reaction to potential RMAs. We acknowledge that reacting to a *potential* RMA is risky because it could waste valuable resources. Historically, it is more common to wait until the RMA has demonstrated major, adverse effects. Unfortunately, that course can prove rather hard on those on the receiving end (e.g., our forward-deployed forces).

If missiles are an RMA, it follows that another RMA is necessary to counter them effectively and efficiently. Incremental improvements to our missile defense capabilities appear unlikely to succeed in the midterm to long term. This is not to suggest that we should not buy more and better missiles, improve our current sensors, make our C2 systems more capable, and so forth. It does suggest, however, that such improvements likely will not provide any lasting benefit since bolstering their effectiveness against missile threats will be increasingly expensive, and the gap between missiles and missile defenses shown in the figure above will continue to widen until the development and fielding of a counter RMA.

We must consider other implications if missiles are indeed an RMA. Although the United States should assume that it would eventually adjust to their use during a conflict, their first use may prove quite damaging. Prudence suggests that America pay far more attention to the actions that could keep its high-value assets from being targeted or, if targeted, much more survivable during those initial missile attacks (i.e., passive defense). Hardening of critical forward-deployed assets, robust dispersal plans, and investments in decoys/dummies should play an expanded role in US defense planning. If one of our assets is too valuable to lose, then we should move it out of likely missile range.

In the event that missiles become an RMA for our adversary, it follows that they will become much more sensitive to crisis deployments of substantial AMD forces into their region. Instead of our "defensive forces" acting as a deterrent to threat offensive actions, they may, in fact, trigger those attacks.[39]

If missiles are an RMA and their initial use is effective against our carriers and forward airfields, then the adversary has put his otherwise inferior air force into a position of potential air superiority. This possibility has huge implications for our regional ground forces, which have not been subjected to serious air attacks since World War II. In the aftermath of the Gulf War, the US Army inactivated its division and corps short-range air defenses based upon the promise of future air superiority.[40] If this promise is now a false one, the Army could find itself in serious trouble. This situation is further compounded by the rapid growth of adversaries' UAS inventories, shown in war games to represent a serious threat.

The possibility of missiles becoming an RMA calls for serious efforts to find a counter RMA. We are not certain what this should be, but some of its characteristics are fairly obvious. First and perhaps foremost, we must be able to afford the AMD solution(s). Ideally, the cost of destroying an incoming missile is far less than that of the adversary missile, and doing so must be within the fiscal means of our friends and allies. Second, the AMD solution(s) must be at least as mobile and deployable as the assets it must protect. Third, an American AMD RMA would necessarily be part of a system of systems. For example, a key aspect of the AMD solution(s) must be the ability to obtain useful target information from a wide variety of sources so that our sensors are not a "single point of failure" for our AMDs. It makes little sense to develop and field an AMD capable of a high volume of fire unless our sensors and fire control have kept pace. Fourth (and preferably), our AMD supporting sensors would be effective, passive ones so that adversaries have no warning of our pending engagement of their missiles or knowledge of where the engagement comes from. Active sensors like radar reveal location as soon as they are turned on. Fifth, an AMD RMA would also have to possess a high degree of horizontally integrated automation across *all* services/countries to effectively counter large and sophisticated missile attacks supported by electronic warfare, UASs, indirect-fire weapons, cyber, aircraft, and the like.[41] It is very unlikely that a single-service solution would suffice. Future AMD acquisi-

tions must make this integration capability a nonnegotiable prerequisite if we wish to maximize joint synergy; thus, current doctrinal revisions and training must make complete integration a priority. We can no longer afford service-centric stovepipe solutions, either operationally or fiscally.[42]

Conclusions

Of course, we cannot just throw up our hands and wait until someone develops a counter RMA. We can do much to maximize our current AMD capabilities. Remember again that the French eventually won the Hundred Years' War, but they did stop charging fixed defenses backed by massed longbows. We may have to buy more missile defense assets as well as continue to upgrade those we currently possess despite their growing expense and relative potential for ineffectiveness. We may also have to consider politically sensitive decisions. For example, if we acknowledge that missiles are an RMA and concede that we cannot defend our most forward air bases or carriers operating close to shore, then perhaps we should move them and their supporting missile defense forces out of the reach of short-range missiles (easier said than done because of the global strategic and regional political effects).

The adversary's massed, structured attacks that combine different types of missiles and enablers are difficult to counter. A key to survival would appear to employ all possible capabilities to desynchronize those strikes.[43] To enable this response, we have noticed in war games a growing requirement to develop and field longer-range and faster standoff weapons that go beyond dependence on manned aircraft. For instance, carrier aviation has difficulty operating against targets in the littorals when the unrefueled range of an F-35 is 690 miles but the range of a DF-21D antiship missile that could attack an aircraft carrier is 1,087 miles.[44] Killing the missile launchers after they launch but before they can move would certainly be a big help in reducing threats over time.[45] Either kinetically or nonkinetically attacking the missile

attack C2 link, space-based ISR, logistics, and enablers is obviously highly desirable if we wish to disrupt missile attacks. We may still put both our high-value assets and our AMD forces within the missile RMA's "sweet spot" for political and diplomatic purposes (deterrence and regional engagement), but we must accept the fact that this may not constitute an effective defensive posture and that many of those forces could be lost in the early stages of a conflict.

Moreover, other actions could be taken. Depending upon the operation, ground forces should assume that they will be attacked by missiles (and aircraft) and reenergize the use of extensive planning for and training in passive defense—*reenergize* because in many cases, this involves relearning the lessons of the Cold War in Europe where we assumed serious threats to our air superiority. We should take another look at our AMD organizational structures because currently the range of threat missiles can exceed the size of our organizational boundaries. Similarly, the Missile Defense Agency now focuses upon ballistic missile defense in accordance with its charter, yet adversaries probably will combine ballistic missiles with cruise missiles, UASs, and aircraft in a single strike. This suggests that perhaps the agency's responsibilities should be expanded to avoid creating unnecessary gaps in our defenses.

We may need to consider an additional strategic factor if missiles have in fact become an RMA. In the past, the initial massive introduction of an RMA to a battlefield has caused significant psychological dislocations of leadership at the highest levels of the affected country—witness the reaction of Allied governments and militaries to the German blitzkrieg of 1939–40. The pervasiveness of the Internet and social media could significantly speed and intensify RMA-induced psychological shocks to the affected governments and populations, which, in turn, could cause "analysis paralysis" that would give additional advantage to the adversary. This phenomenon has in fact been observed in several recent service-level war games. These types of psychological shocks should be incorporated into high-level strategic war games to

facilitate understanding among senior decision makers as a step toward mitigation of adverse political effects.

One last point to consider regarding missiles as an RMA concerns the impact of their first use on the current world order. For example, if the United States suddenly finds its ability to conduct cost-effective global power projection curtailed, we could anticipate a dramatic political and diplomatic shift in favor of regional centers of power. This development, in turn, would likely create difficulties for our global system of alliances. If America cannot protect its regional friends and allies, then they may be reluctant to support US positions.[46] They may also be more interested in developing classes of strategic weapons for their self-protection, an action that could run contrary to US interests. Global stability would likely suffer with corresponding economic shocks.

The opposite is true if adversary missiles are not an RMA. In this case, apparent insights from the recent service war games are either overstated or invalid. Our incremental missile defense improvements will therefore prove sufficient, and missiles will pose no threat to our global projection of power. The first attacks of the next conflict will be serious but not devastating. Further, we can avoid expensive research and development efforts for a counter RMD.

The evidence, however, indicates that our adversaries' missile capabilities are, in fact, an RMA. The United States and its allies can either choose to overcome internal bureaucratic resistance and address this issue now or wait until future battlefield disasters create the political impetus for change. ✪

Notes

1. By relative parity, the author means that missile defenses had a rough balance versus threat missiles. The exact results of the Patriot engagements have been widely debated, but we generally agree that this missile negated some of the threats, that those engagements reassured coalition allies, and that the Patriot probably kept Israel out of the first Gulf War.

This "relative parity" statement is more than simply a function of offensive missile versus defensive missile. For example, threat missile attack doctrine called for launching inaccurate single missiles at relatively predictable times into Patriot-defended areas with minimal ability to conduct a battle damage assessment, except for that announced on public news broadcasts. Threat technical capabilities, total numbers of available missiles, and missile attack doctrine have evolved significantly since 1991. The consideration of missile defenses against strategic threats to the United States (e.g., intercontinental ballistic missiles) lies outside the scope of this article.

2. The SCUD, in turn, was based upon the German V-2 missiles of World War II. SCUDs and their variants have been widely proliferated and exist worldwide in large numbers.

3. Insights used in this paper were based upon US Army Space and Missile Defense Command / Future Warfare Center / Battle Lab / Concepts and Wargames Division consolidated observations from Unified Engagement 08, Unified Quest 08, Future Game 09, Unified Quest 09, Unified Quest 10, Unified Quest 12 PLANEX, Unified Quest 12 Capstone, Unified Engagement 10, Nimble Titan 10, Nimble Titan 12, Expeditionary Warrior 12, Unified Engagement 12, Schriever Wargame 12, Future Game 13, Unified Quest 13 Capstone, Army Joint Forcible Entry Experiment, Army Combined Arms Maneuver–Wide Area Security Experiment, and Army Gain and Maintain Operational Access Experiment–Army Fires Experiment Tactical to Strategic.

4. The term *threat missile forces* refers to ballistic missiles, cruise missiles, and long-range rockets (many of which have characteristics similar to those of ballistic missiles).

5. The term *revolution in military affairs* (*RMA*), popular in the 1990s, was used to describe a revolutionary change in warfare. Although *RMA* has fallen out of use somewhat in the last decade, I am using the term because it seems to offer a common frame of reference to many readers.

6. Andrew F. Krepinevich, "Cavalry to Computer: The Pattern of Military Revolutions," *National Interest*, no. 37 (Fall 1994): 30.

7. Richard O. Hundley, *Past Revolutions, Future Transformations: What Can the History of Revolutions in Military Affairs Tell Us about Transforming the U.S. Military?*, MR-1029-DARPA (Santa Monica, CA: RAND, 1999), 9.

8. Fortifications eventually underwent a radical redesign so that the defense could reset the balance (and to a large measure regain dominance until the appearance of tanks in World War I).

9. Gunpowder artillery forces became more common during the Hundred Years' War but, admittedly, remained relatively weak until after that war.

10. This included the dismounting of knights and men at arms and equipping them with pole arms to prevent the adversary's surviving mounted knights from breaking through. After the introduction of powered projectiles (crossbows/longbows and cannon), castles and armored cavalry did not go away. They were still important, but their role shifted. Castles became magazines, and one had to keep the adversary at arm's length from the castles/magazines or suffer siege. Cavalry became lighter and key to ISR collection and exploitation. For a discussion on innovative technology versus cost-benefits, see T. X. Hammes's excellent article "The Future of Warfare: Small, Many, Smart vs. Few & Exquisite?," War on the Rocks, 16 July 2014, http://warontherocks.com/2014/07/the-future-of-warfare-small-many-smart-vs-few-exquisite/.

11. Note that the combat effectiveness of massed longbows had been previously demonstrated in England starting in the late thirteenth century. One finds (1) a tendency not to give the threat (the English) credit for studying a great power (France) and for drawing lessons that the English then applied to meet their operational and strategic goals, and (2) a failure to look at how technologies can be combined and applied to solve military problems—that is, a failure of operational imagination combined with bureaucratic resistance (i.e., the nobility). This point is important since historically it appears that these same factors have prevented most adaptations to an RMA prior to a battlefield disaster—neglecting to understand the nature of the threat and how it has evolved as well as failing to adapt in meaningful ways because of unwillingness to discard what has worked in the past.

12. Andrew F. Krepinevich Jr., "Strategy in a Time of Austerity: Why the Pentagon Should Focus on Assuring Access," *Foreign Affairs* 91, no. 6 (November/December 2012): 58–69.

13. Jan van Tol et al., *AirSea Battle: A Point-of-Departure Operational Concept* (Washington, DC: Center for Strategic and Budgetary Assessments, 2010), 2.

14. *Antiaccess* refers to "those capabilities, usually long-range, designed to prevent an advancing enemy from entering an operational area." Department of Defense, *Joint Operational Access Concept (JOAC)*, version 1.0 (Washington, DC: Department of Defense, 17 January 2012), 40, http://www.defense.gov/pubs/pdfs/joac_jan%202012_signed.pdf. *Area denial* refers to "those capabilities, usually of shorter range, designed not to keep the enemy out but to limit his freedom of action within the operational area." Ibid.

15. It is certainly true that our potential adversaries have many other antiacess/area-denial (A2AD) capabilities (e.g., mines, UASs, submarines, and large militias), but their missile forces are the core of their A2AD strategies—witness the number of resources they are dedicating to them. The adversary's coupling of WMD and missile-delivery capabilities is wonderfully described in Paul Bracken's book *Fire in the East: The Rise of Asian Military Power and the Second Nuclear Age* (New York: HarperCollins, 1999), which notes that the existence of threat WMDs makes all threat area-denial actions more effective even if these weapons are never used. If WMD capabilities keep regime change from occurring, then time is on the side of that adversary and costs imposed by his area-denial efforts will continue to escalate. The adversary's WMD capabilities place operational restraints upon the United States by creating potential "red lines." The enemy may be far less constrained, as appears to be the case in recent service Title 10 war games.

16. See, for example, Kamlesh K. Agnihotri, "China's 'Anti-ship Ballistic Missile' Based Anti-access Concept: Implications of a Southward Re-orientation," *Journal of Defence Studies* 7, issue 1 (January 2013): 19–20; Justin Kelly, "Fighting China: Airsea Battle and Australia," *Australian Army Journal* 9, no. 3 (Summer 2012): 157–58; and Daniel Hartnett, *Air-Sea Battle, China, and the U.S. Rebalance to Asia* (Washington, DC: Center for National Policy, November 2013), 3.

17. In addition to other references noted in this section, the author used his personal observations from the following: Unified Engagement 08, Unified Quest 08, Future Game 09, Unified Quest 09, Unified Quest 10, Unified Quest 12 PLANEX, Unified Quest 12 Capstone, Unified Quest 13 Deep Futures, Unified Engagement 10, Nimble Titan 10, Schriever Wargame 12, Unified Engagement 12, Nimble Titan 12, Future Game 13, Army Joint Forcible Entry Experiment, Army Combined Arms Maneuver–Wide Area Security Experiment, Army Gain and Maintain Operational Access Experiment–Army Fires Experiment Tactical to Strategic, and Army SIMEX 13.

18. See, for example, Office of the Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China, 2013* (Washington, DC: Office of the Secretary of Defense, 2013), 31.

19. For example, from Kosovo "it is also striking that NATO could not find and destroy most systems that were mobile and which did not actively use their radars and that the SA-6—the only quasi-modern and effective system in Serbian inventory—largely survived the war." Anthony H. Cordesman, *The Lessons and Non-Lessons of the Air and Missile Campaign in Kosovo* (Washington, DC: Center for Strategic and International Studies, August 2000), 187, http://csis.org/files/media/csis/pubs/kosovolessons-full.pdf. An SA-6 has mobility comparable to that of a modern missile transporter erector launcher. For two videos of abandoned SCUDs discovered after Odyssey Dawn that were not apparently targeted, see "SCUD-B Missiles Found in Libya," Military.com, 4 November 2011, http://www.economat.armees.com/video/guided-missiles/multipurpose-missiles/scud-b-missiles-found-in-libya/1258775990001/; and "Rebels Find Scud Missile in Sirte," Military.com, 17 October 2011, http://www.economat.armees.com/video/guided-missiles/multipurpose-missiles/rebels-find-scud-missile-in-sirte/1222311595001/.

20. Kenneth Allen and Maryanne Kivlehan-Wise, "Implementing PLA Second Artillery Doctrinal Reforms," in *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Arts of the Chinese People's Liberation Army*, ed. James C. Mulvenon and David Finkelstein (Alexandria, VA: Center for Naval Analysis, 2005), 159–60, http://www.defensegroupinc.com/cira/pdf/doctrinebook_ch6.pdf.

21. Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey Summary Report* (Washington, DC: Office of the Secretary of the Air Force, 1993), 83–90.

22. Matthew Fargo, "Ballistic Missile Technology 101—Rocket Fuel" (Washington, DC: Center for Strategic and International Studies, 8 August 2012), https://csis.org/blog/ballistic-missile-technology-101-rocket-fuel. See also Sean O'Connor, "PLA Second Artillery Corps," Technical Report APA-TR-2009-1204, Air Power Australia, December 2009, http://www.ausairpower.net/APA-PLA-Second-Artillery-Corps.html.

23. For an excellent description of how advanced ISR capabilities enable missile attacks, see Ian Easton, *China's Evolving Reconnaissance-Strike Capabilities: Implications for the U.S.-Japan Alliance* (Tokyo: Japan Institute of International Affairs, February 2014), http://www.project2049.net/documents/Chinas_Evolving_Reconnaissance_Strike_Capabilities_Easton.pdf.

24. Lee Fuell, *Presentation to the U.S.-China Economic and Security Review Commission: Broad Trends in Chinese Air Force and Missile Modernization* (Washington, DC: Department of the Air Force, 30 January 2014), 7, http://www.uscc.gov/sites/default/files/Lee%20Fuell_Testimony1.30.14.pdf; and Office of the Secretary of Defense, *Annual Report to Congress*, 5–6, 31–33.

25. Current estimates for the flyaway cost of a single F-35 range from $600 million to more than $750 million.

26. "However, DOD is still investing heavily in programs that may be vulnerable to A2/AD strategies." LTG David W. Barno, USA, Retired, et al., *Sustainable Pre-eminence: Reforming the U.S. Military at a Time of Strategic Change*, Responsible Defense Series (Washington, DC: Center for a New American Society, May 2012), 19, http://www.cnas.org/files/documents/publications/CNAS_SustainablePreeminence_BarnoBensahelIrvineSharp_0.pdf.

27. Squadron Leader R. S. Clarke, *The Regional Emergence of Strategic Missiles: A Force of Rooks for a Black King*, Air Power Studies Centre Working Paper no. 55 (Commonwealth of Australia: Air Power Studies Centre, 1997), http://fas.org/irp/threat/missile/paper55.htm.

28. Yuen Lin, "Probing the Capability of Taiwan's Antiballistic Missiles," *Kuang Chiao Ching*, 16 August 1998, 54–61.

29. Toshi Yoshihara and James R. Holmes, *Red Star over the Pacific: China's Rise and the Challenge to U.S. Maritime Strategy* (Annapolis, MD: Naval Institute Press, 2010), 102.

30. CAPT Henry J. Hendrix, USN, *At What Cost a Carrier?*, Disruptive Defense Papers (Washington, DC: Center for a New American Society, March 2013), 7, http://www.cnas.org/files/documents/publications/CNAS%20Carrier_Hendrix_FINAL.pdf.

31. Allen and Kivlehan-Wise, "Implementing PLA Second Artillery Doctrinal Reforms," 196–98.

32. The Missile Defense Agency has conducted 80 hit-to-kill intercept tests since 2001, including Aegis, ground-based midcourse defense, Terminal High Altitude Area Defense, and Patriot Advanced Capability–3—an average of roughly six per year. "Ballistic Missile Defense Intercept Flight Test Record," fact sheet, Missile Defense Agency, 22 June 2014, http://www.mda.mil/global/documents/pdf/testrecord.pdf. On 18 April 2014, North Korea test-fired 30 short-range missiles in a little over two hours. Bonnie Malkin, "North Korea Test Fires 30 Missiles into the Sea," *Telegraph*, 22 March 2014, http://www.telegraph.co.uk/news/worldnews/asia/northkorea/10716033/North-Korea-test-fires-30-missiles-into-the-sea.html. On 9 July 2008, Iran launched nine missiles in a single morning. *Wikipedia: The Free Encyclopedia*, s.v. "Great Prophet III," http://en.wikipedia.org/wiki/Great_Prophet_III. "The three day exercise, called Great Prophet 7, involves firing 'tens of different missiles' at bases modeled after United States military installations in countries like Afghanistan and Saudi Arabia, Iran's Revolutionary Guards military force told IRNA, AFP reports." "Iran Starts War Games after Being Hit with Sanctions over Its Nuclear Program," *Fox News*, 2 July 2012, http://www.foxnews.com/world/2012/07/02/iran-starts-war-games-after-being-hit-with-sanctions-over-its-nuclear-program/. See also Amaani Lyle, "Official Discusses Chinese Air Force, Missile Trends," American Forces Press Service, 30 January 2014, http://www.defense.gov/news/newsarticle.aspx?id=121582.

33. See Bracken, *Fire in the East*.

34. Note the difficulty that Brig Gen William "Billy" Mitchell had in convincing senior Navy personnel of the potential of aircraft in attacking and sinking ships. He is said to have asserted that 1,000 bombers could be built for the cost of one battleship. Of course the Japanese at Pearl Harbor drove the lesson home. Again note the cost differential between a modern fourth- or fifth-generation strike fighter and adversary missiles.

35. Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of Their Intermediate-Range and Shorter-Range Missiles, signed at Washington, 8 December 1987, Articles IV and V, http://www.nti.org/media/pdfs/aptinf.pdf?_=1316643952&_=1316643952.

36. The English lost all of their continental territory except the Pas-de-Calais.

37. The French and British had better and more tanks than the Germans in 1940, but they were not part of an integrated system of systems with other battlefield enablers like the German tanks; therefore, they were defeated in detail.

38. Each of the four US military services conducts an annual war game that looks out at least 10 years. These are usually referred to as "Title 10" war games, which typically focus

on potential future operational scenarios validated by the Defense Intelligence Agency. Each war game is supported by a "thinking" Red Team that operates within the doctrine and projected capabilities of the "threat" country portrayed in the war game.

39. This "triggering" phenomenon was observed in several recent war games. As soon as the adversary detected the initial arrival of US AMD forces in his theater during a crisis, he attacked with overwhelming missile strikes. The enemy's rationale was that he should use his missile capabilities while they are at their most effective.

40. "The Army is now engaged in a large scale restructuring of its forces, which includes reducing the numbers of SHORAD [short-range air defense] and FA [field artillery] units and changing their composition while increasing the number of frontline combat units. . . . It would eliminate all SHORAD units in the Army and restructure FA units into a smaller number of larger battalions (eliminating numerous brigade, battalion, and company headquarters) while doing away with corps-level cannon artillery battalions. Finally, it would eliminate some support units associated with the discontinued SHORAD and FA units. . . . The rationale for doing away with SHORAD units is that U.S. tactical aircraft have rapidly achieved air superiority (and sometimes full air supremacy) in every conflict they have engaged in since World War II and that U.S. SHORAD units have not destroyed a hostile aircraft since 1950." Congressional Budget Office, *Budget Options* (Washington, DC: Congress of the United States, Congressional Budget Office, February 2005), 12, https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/60xx/doc6075/02-15-budgetoptions.pdf. The Army plan was later modified to retain two SHORAD battalions (5-5 Air Defense Artillery and 2-44 Air Defense Artillery) to perform counter-rocket, artillery, and mortar (C-RAM) defense of base camps in Iraq and Afghanistan.

41. By "horizontally integrated automation," I mean that, in real time, we will need to automatically share data with all other battlefield C2 systems, rapidly process all received data into useful information, and prioritize efforts and decisions based upon that information.

42. By "service-centric stovepipe solutions," the author means solutions that are neither integrated nor easily integratable into a holistic joint and coalition AMD architecture.

43. The "desynchronization" of an adversary's ability to orchestrate massive sustained attacks was also at the heart of the Air Land Battle Concept of the 1980s. Van Tol et al., *AirSea Battle*, 5–7.

44. Hendrix, *At What Cost a Carrier?*, 8. Further, we would not likely fly air-to-air refueling tankers within the range of an adversary's modern air defense systems. For example, the Russian S-400 has an engagement range of 250 miles, and the Russian S-500 has a planned range of 373 miles. Van Tol et al., *AirSea Battle*, 25.

45. Attacking missile launchers on an adversary's mainland would be a critical strategic decision because it could give him justification for striking US territory. Moreover, a decision to attack an opponent preemptively, before he could initiate hostilities, has significant international implications, especially if coalition members are involved. In the absence of a political decision to permit preemptive attack, the ability to withstand the adversary's initial attacks is paramount.

46. Van Tol et al., *AirSea Battle*, 13–14.

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